Distal femoral fractures treated by hinged total knee replacement in elderly patients

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Although the use of constrained cemented arthroplasty to treat distal femoral fractures in elderly patients has some practical advantages over the use of techniques of fixation, concerns as to a high rate of loosening after implantation of these prostheses has raised doubts about their use. We evaluated the results of hinged total knee replacement in the treatment of 54 fractures in 52 patients with a mean age of 82 years (55 to 98), who were socially dependent and poorly mobile.

Within the first year after implantation 22 of the 54 patients had died, six had undergone a further operation and two required a revision of the prosthesis. The subsequent rate of further surgery and revision was low.

A constrained knee prosthesis offers a useful alternative treatment to internal fixation in selected elderly patients with these fractures, and has a high probability of surviving as long as the patient into whom it has been implanted.

In patients with distal femoral metaphyseal fractures, open reduction and internal fixation, using either screw-plate or blade-plate devices, has traditionally been considered to be the most appropriate treatment, although the recent development of femoral locking plates and retrograde intramedullary nails has allowed this surgery to be performed in a less invasive manner. However, such fractures are usually comminuted and occur more often in elderly patients with osteoporosis who may have pre-existing osteoarthritis of the knee or hip implants. In these circumstances, unstable reduction and osteosynthesis may not be achievable and if fixation fails, further surgery may be required.

Even with a successful reconstruction, the internal fixation may not be stable enough to allow early weight-bearing and splintage of the limb may be needed.

The elderly patients who sustain these injuries usually have limited functional expectations, and there is a high mortality within the first year after injury. In order to reduce the risk of complications the use of a hinged joint replacement as a primary definitive treatment in this group of frail individuals is an alternative to internal fixation. The benefits of this approach have been demonstrated previously in the treatment of fractures around the hip, shoulder and distal humerus. We have previously reported a low risk of early complications using this technique, as have others. However, the high rate of loosening and mechanical failure of this type of prosthesis, when used to treat degenerative arthritis of the knee, raises concerns about whether similar complications may occur when managing fractures around the knee.

To our knowledge a comprehensive review of the long-term outcome of this method of treatment in a large series has not been undertaken. Our aim was to evaluate the mortality, the incidence of peri-operative complications and the subsequent level of social dependency in a large series of patients treated by this technique. In addition, we have assessed the longer term prosthetic survival to revision for implant-related complications.

Patients and Methods

Between 1987 and 2004, we treated 54 displaced distal femoral metaphyseal fractures in 52 patients with a primary cemented hinged total knee replacement. In the two patients with bilateral fractures the injuries were three and five years apart. Use of the technique was restricted to those aged 55 years or older who were socially dependent, either living in the community with support from social services or from relatives, or living in residential or institutional care, and not able to walk outside, but medically fit for anaesthesia. There were three men and 49 women with a mean age of 82 years (55 to 98). Only four were aged under 55 years old.
70 years. Of the 52 patients, nine (17%) were unable to walk, 25 (48%) walked with the assistance of a Zimmer frame or two helpers, 11 (21%) used one walking aid or one helper, and seven (14%) could walk without assistance. None regularly walked outside their residence and all of the injuries were sustained in simple domestic falls from or below standing height. Evidence of chronic cognitive impairment was present in 23 patients (44%). Before their injury, ten (19%) were living in the community, with support from social services or relatives, while the remaining 42 (81%) were in residential accommodation or long-term care in either an institution or nursing home.

Demographic information on all patients was prospectively coded onto a trauma database. The early and late post-operative complications, including prosthetic revision, were also recorded in the patient’s trauma records. Since our hospital provides the only source of care of orthopaedic trauma for the local community, no patient who was locally resident was treated elsewhere.

A single observer (SH) retrospectively classified the original anteroposterior and lateral radiographs. Using the AO system for distal femoral metaphyseal fractures, nine (17%) were ‘low’ type 33-A3 (extra-articular but comminuted) and 45 (83%) were type 33-C (bicondylar articular) fractures. Minor age-related wear changes were apparent radiologically in most knees on the pre-operative radiographs, but 12 (22%) had severe degenerative changes of the knee at the time of surgery. Of the 54 fractured limbs, 22 (41%) had previously undergone surgery to the hip. Fracture implants were present in 19 (86%) of these patients with 14 dynamic hip screws and five hemiarthroplasties, while the remaining three patients (14%) had previously undergone cemented total hip replacement for osteoarthritis.

Operative technique. Six orthopaedic traumatologists who were experienced in the use of the technique performed all the operations. We used standard pre-operative antithrombotic (low molecular weight heparin) and antibiotic (broad-spectrum cephalosporin) prophylaxis. The surgery was performed under general or spinal anaesthesia within five days of injury, under tourniquet control using a midline longitudinal incision and a medial parapatellar approach. The femur distal to the fracture was excised with its attached collateral ligaments and the tibial articular surface was excised. Two fractures were treated using a Kotz prosthesis (Stryker-Howmedica, Newbury, United Kingdom) early in the series. We subsequently used the Guepar prosthesis (Stryker-Howmedica) for 38 fractures treated between 1987 and 1999 and the Stanmore hinged prosthesis (Biomet, Bridgend, United Kingdom) to treat the remaining 14 fractures between 1999 and 2004. All of these prostheses were non-customised implants with long-stemmed femoral and tibial components linked intra-operatively using a transverse metal rod and polyethylene bushings. Trial components were initially assembled uncemented to ensure adequate anatomical restoration of the joint line and soft-tissue tensioning. After medullary lavage and drying of the medullary canals, both femoral and tibial components were cemented into place and re-coupled. The canals were unplugged and the cement was injected retrograde and pressurised. We also used bone cement to fill up significant metaphyseal bone defects in the distal femur.

Post-operatively, no splints or orthoses were used and all patients who were able to walk before their injury were mobilised with the re-introduction of weight-bearing as tolerated from the second post-operative day. No specific mobilisation programme was instituted, other than physiotherapy and occupational therapy to supervise and regain confidence with the use of walking aids to improve mobility.

Assessment of outcome and evaluation of results. Since the purpose of our review was a pragmatic assessment of the consequence of our treatment policy in a selected elderly group of patients, we used mortality, length of hospital stay, restoration of mobility, the incidence of post-operative complications relating to the implant and prosthetic survival as the main outcome measures. Since the procedure was used only in patients who were relatively immobile and often frail or mentally impaired, we found that it was impractical to obtain functional assessment using standard knee functional scoring systems. We linked our patients’ clinical information to the computerised local registry of deaths to gather information on post-injury mortality and to analyse prosthetic survival.

Results
The mean length of in-patient stay in our acute trauma service ward was 15 days (12 to 23). Two patients died from pneumonia and one from cardiac failure in the first ten days after surgery. Of the 39 patients (75%) who had been living in residential accommodation or long-term institutional or nursing home care before injury and who survived the period in the acute ward, 12 (31%) were transferred directly back to their previous residence from the acute ward and 27 (69%) for rehabilitation in an orthogeriatric assessment unit. Of these patients, 18 (67%) eventually returned to their previous accommodation and nine (33%) died on the rehabilitation ward. Of the ten surviving patients (19%) who were admitted from their own homes or sheltered housing before their injury, only two (20%) were able to be discharged directly home, while the remaining eight (80%) required a period of rehabilitation. Of these patients, three ultimately required private nursing-home care, two were able to be discharged back to their previous residence after rehabilitation and three died in the rehabilitation ward. At one year after injury, 22 patients (42%) had died, but among the survivors the level of dependency in their place of residence was not altered, and all had regained their previous level of mobility.

Survival analysis showed that the mortality within the first year after fracture was 41.1% (95% confidence interval (CI) 27.9 to 54.3) rising to 82.0% (95% CI 71.1 to 92.9) after five years and 97.3% (95% CI 92.2 to 100) after
The median survival after fracture was 1.7 years (95% CI 0.9 to 2.5). In all cases the cause of death on certification was attributed to medical co-morbidities, most commonly cardiopulmonary disease and disseminated malignancy.

Since a considerable number of the patients did not survive long enough to develop implant-related complications, we used survival analysis to assess the rate of re-operation and that of prosthetic revision. With censorship of patients at the time of death or loss to follow-up, the cumulative rate of re-operation for a fracture-related complication at one year after injury was 13.6% (95% CI 3.4 to 23.8) which rose to 18.1% (95% CI 5.4 to 30.8) by three years (Table II), but with no further re-operation.

Of the seven patients who required a further procedure, one developed an acutely ischaemic foot 25 months after the initial operation and required an above-knee amputation. One developed a post-operative haematoma of the wound, which was successfully treated by surgical evacuation, lavage and immediate wound closure. This patient later ruptured a patellar tendon 15 months after surgery and had a successful repair without further complications. One patient developed a deep wound infection, which was uncontrolled by repeated debridement and eventually required an above-knee amputation.

Four patients sustained a peri-prosthetic fracture at the tip of the femoral component in simple falls within the first three months after implantation (Fig. 1). Three of these fractures occurred between the hinged knee and a previously inserted hip implant (two cemented total hip replacements and one dynamic hip screw). All were treated by open reduction and plate fixation, supplemented by cerclage wiring (Fig. 1). In three of these patients the original hinged knee was retained and in one revision of the femoral component was required for loosening of the cement mantle. All four peri-prosthetic fractures healed satisfactorily.

Three patients required revision or removal of the original total knee replacement (two above-knee amputations and one peri-prosthetic fracture with a loose prosthesis) producing a cumulative rate of revision of the original knee replacement on survival analysis of 4.6% (95% CI 0 to 10.9) at one year after injury, rising to 9.1% (95% CI 0 to 19.7) at three years, but with no further revisions thereafter (Table III).

**Discussion**

We have described the results of treatment in a small well-defined group of elderly, dependent and medically frail patients with difficult fractures of the distal femur in whom...
the anticipated results from either non-operative treatment or operative reduction and internal fixation would have been poor. Our results show that the mortality rate during the first post-operative year of 4.1% from medical co-morbidities in this group is greater than that for patients with proximal femoral fractures.\textsuperscript{40,41} The goals of treatment differ from those in younger patients, with the main aim being the early restoration of a stable limb which will allow the

Table III. Survival analysis for revision of the prosthesis after implantation of a primary hinged total knee replacement

<table>
<thead>
<tr>
<th>Start time (yrs)</th>
<th>Number entering per year</th>
<th>Number withdrawn due to death or loss to follow-up</th>
<th>Number at risk</th>
<th>Number of revisions</th>
<th>Cumulative percentage of patients who had undergone revision at the end of the time period (95% CI)</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>54</td>
<td>21</td>
<td>43.5</td>
<td>2</td>
<td>4.6 (0 to 10.9)</td>
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<tr>
<td>1</td>
<td>31</td>
<td>8</td>
<td>27</td>
<td>0</td>
<td>4.6 (0 to 10.9)</td>
</tr>
<tr>
<td>2</td>
<td>23</td>
<td>4</td>
<td>21</td>
<td>1</td>
<td>9.1 (0 to 19.7)</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
<td>4</td>
<td>16</td>
<td>0</td>
<td>9.1 (0 to 19.7)</td>
</tr>
<tr>
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<td>14</td>
<td>3</td>
<td>12.5</td>
<td>0</td>
<td>9.1 (0 to 19.7)</td>
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<tr>
<td>5</td>
<td>11</td>
<td>3</td>
<td>9.5</td>
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<td>9.1 (0 to 19.7)</td>
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<tr>
<td>6</td>
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<tr>
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<td>2</td>
<td>2</td>
<td>0</td>
<td>9.1 (0 to 19.7)</td>
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\* 95% CI, 95% confidence interval

Figure 1a – Anteroposterior and lateral radiographs of an 83-year-old woman who fell sustaining an AO type 33-C distal femoral metaphyseal fracture with displacement. Figure 1b – Since she was relatively immobile, the fracture was initially treated by a Stanmore hinged knee replacement. She fell again six weeks later sustaining a peri-prosthetic fracture at the tip of the stemmed femoral component. Figure 1c – The fracture was treated by open reduction and plate fixation with cerclage wiring. Although her peri-prosthetic fracture subsequently healed, she died 14 months later.
patient to mobilise or transfer at an early stage, depending on their previous level of mobility.

The use of a hinged knee replacement satisfies these requirements. Most of our patients were allowed to mobilise at an early stage without needing ancillary splintage, and their period of acute in-patient stay was minimised before discharge back to their previous level of accommodation or transfer to an orthogeriatric rehabilitation unit. The mean length of in-patient stay of our patients was 15 days, which compares favourably with a mean stay of 31 days when internal fixation techniques were used.\(^2,5,6,14,19\)

There was subsequently an increase in the level of social dependency in some of the surviving patients, which reflected their declining physiological status, rather than impairment of their mobility from the fracture, since the pre-injury level of mobility was restored in the surviving patients at one year after injury.

Previous studies have reported the use of knee replacement to treat 68 distal femoral fractures, including 22 established cases of nonunion and 46 acute fractures.\(^2,5,34,42\) The surgical techniques and type of prosthesis have varied considerably, ranging from excision of the fracture fragments and implantation of a constrained replacement,\(^27,29,31,32\) fracture fixation and simultaneous primary unconstrained replacement\(^31\) and primary unconstrained replacement with a long-stemmed femoral component.\(^28,30,42\) Retention of the fracture fragments with their attached collateral ligaments allows the use of a primary resurfacing knee replacement, rather than a constrained prosthesis. However, the use of a resurfacing replacement in an elderly patient increases the risk of fracture-related complications, and it is probably best reserved for younger patients with more proximal extra-articular AO type 33-A fractures with a large distal fragment and co-existing osteoarthritis of the knee.

Our series represents the largest study of the use of a hinged knee replacement to treat distal femoral fractures to date. We have been able to quantify the risks of post-operative complications, implant survival and mortality. However, because of the poor physiological status of the patients who were selected to undergo this procedure, and who were unable to complete detailed functional outcome questionnaires, we were unable to make any detailed statements about how these prostheses functioned once implanted.

Other techniques, such as the 95° dynamic condylar screw\(^4\) or blade plate\(^1\) and more recently retrograde locked intramedullary nailing\(^14\) and minimally-invasive locked plate fixation\(^8\) have been used successfully, even in elderly patients. However, in such patients it is rare for open reduction and internal fixation to restore sufficient stability to allow early mobilisation and weight-bearing, and supplementary support with a brace may be required.\(^19\) In addition, complications requiring further surgery for either infection, fixation failure or nonunion are more likely to occur when these techniques are used.

Peri-prosthetic fracture within the first three months after surgery was the most common and most serious early post-operative complication. Despite the small numbers of patients involved, the presence of a hip implant appeared to be associated with an increased risk of this occurrence, since peri-prosthetic fractures occurred in three of the 22 femora (14%) with a pre-existing hip prosthesis, and in only one of the remaining 32 (3%) with no hip implant. The presence of two long-stemmed implants introduced through opposite ends of the femur produces a substantial stress riser when the two implants meet at the femoral isthmus. The increased risk of peri-prosthetic fracture in the presence of a previous hip implant is therefore not confined to the use of a long stemmed total knee replacement to treat the distal femoral fracture, and may also occur when either intramedullary nailing or plate fixation are used.

This technique provides a relatively simple method of treatment for a difficult fracture. With appropriate patient selection, the prosthesis has a high probability of surviving as long as the patient into whom it is implanted, and if there is co-existing symptomatic arthritis of the knee, this may be definitively treated by the surgery. The subsequent risk of nonunion is abolished, and the risk of implant failure, malalignment and deep infection is low. However, the technique should be used with caution in the presence of a pre-existing proximal hip implant, in which case the best treatment has still to be identified. A prospective, randomised trial of the use of primary knee replacement compared with new fixation techniques, such as minimally-invasive locked plating, is needed to address the relative merits of each method.

Supplementary Material

A table showing the details of a literature review, and a full list of references is available with the electronic version of this article on our website at www.jbjs.org.uk

We would like to thank the other Consultants working in the Edinburgh Orthopaedic Trauma Unit for allowing access to details of patients under their care.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References